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THE SENSES

INTRODUCTION

Philosophers and scientists have studied sensory perception and, in particular, vision for many years. Increasingly, however, they have become interested in the nonvisual senses in greater detail and the problem of *individuating the senses* in a more general way. The Aristotelian view is that there are only five external senses—smell (see [*Sensory Modalities: Olfaction*](#)), taste (see [*Sensory Modalities: Taste and Flavor*](#)), hearing (see [*Sensory Modalities: Audition*](#)), touch (see [*Sensory Modalities: Touch*](#)), and vision (see [*Sensory Modalities: Vision*](#)). This has, by many counts, been extended to include internal senses, such as balance, proprioception, and kinesthesia (see [*Sensory Modalities: Bodily Awareness*](#)); pain (see [*Sensory Modalities: Pain*](#)); and potentially other human (see [*Sensory Modalities: Other Human Senses*](#)) and nonhuman senses (see [*Sensory Modalities: Nonhuman Senses*](#)). This “multisensory turn” has been driven partly by developments in contemporary psychology and neuroscience (see [*Anthologies: Psychology and Neuroscience*](#)), which have revealed a host of complex interrelations and interactions between sensory modalities previously thought to be distinct. Contrasts between modalities (see [*Contrasting the Senses*](#)) and other crossmodal phenomena, including multisensory integration (see [*Crossmodal Phenomena*](#)), synesthesia (see [*Crossmodal Phenomena: Synesthesia*](#)), and sensory substitution (see [*Sensory Enhancement and Deficits: Sensory Substitution*](#)), have also begun to receive more attention in a burgeoning scientific and philosophical literature on multisensory perception (see [*Crossmodal Phenomena: Multisensory Perception*](#)) and other crossmodal effects (see [*Crossmodal Phenomena: Other Crossmodal Phenomena*](#)). This article focuses on recent empirically informed contributions to the philosophy of perception, as well as key scientific works that provide important background information and insights into the nature of the senses and sensory perception. Indeed, one of the lessons of the multisensory turn, and of contemporary philosophy of mind more generally, is that philosophers ignore this body of empirical research at their peril because many human and animal senses turn out to be richer and more complex than philosophers and scientists had previously imagined, making this a fruitful area for interdisciplinary interaction and research. (The authors would like to thank David Bain, Clare Batty, Jennifer Corns, Robert Cowan, Ophelia Deroy, Alistair Isaac, Barry Smith, Charles Spence, Dustin Stokes, and an anonymous

reviewer for Oxford Bibliographies for their comments and suggestions. This work was supported by a grant from the Arts and Humanities Research Council, grant number AH/L007053/1.)

ANTHOLOGIES AND REFERENCE

In keeping with the multidisciplinary nature of the study of the senses, key reference works in philosophy, psychology and neuroscience, and history and anthropology have been included that may be of interest to philosophers working in this area. Anthologies and books that relate primarily to individual sensory modalities, crossmodal phenomena, and animal perception are referenced under the relevant sections.

Philosophy

Although as of the mid-2010s, no general textbooks are available on the philosophy of the senses, as opposed to perception and philosophy of mind more generally; however, the anthologies and collections cited in this section provide a representative overview of the literature. These include contributions from many philosophers who have actively engaged with the empirical literature (see [*Psychology and Neuroscience*](#)), as well as many of the works cited elsewhere in this article. A good starting point is [Macpherson ed. 2011](#), which contains a selection of influential historical and contemporary papers that focus, although not exclusively, on the individuation of the senses (see [*Individuating the Senses*](#)). [Stokes, et al. 2015](#) and [Bennett and Hill 2014](#) provide recent additions to the literature, particularly in the areas of multisensory perception, attention and awareness, and comparisons of different sensory modalities (see [*Contrasting the Senses*](#)). [Matthen 2015](#) offers comprehensive overviews of a wide range of topics on the philosophy of perception and the senses, each written by subject experts and containing detailed bibliographical references, making it an excellent resource for further research.

Bennett, David J., and Christopher Hill, eds. *Sensory Integration and the Unity of Consciousness*. Cambridge, MA: MIT Press, 2014. [ISBN: 9780262027786]

[A wide-ranging collection of recent essays with a particular focus on multisensory perception and the way in which relationships between various senses \(see \[*Contrasting the Senses*\]\(#\)\) gives rise to unified conscious experiences.](#)

Macpherson, Fiona, ed. *The Senses: Classic and Contemporary Philosophical Perspectives*. New York: Oxford University Press, 2011. [ISBN: 9780195385960]

[This philosophical collection is the first to address the individuation of the senses directly \(see \[*Individuating the Senses*\]\(#\)\) and includes key historical and new works. A good starting point for further reading and research.](#)

Matthen, Mohan, ed. *The Oxford Handbook of Philosophy of Perception*. Oxford: Oxford University Press, 2015. [ISBN: 9780199600472]

[A comprehensive guide to contemporary philosophy of perception. Each chapter provides a critical overview of the relevant subtopic written by subject experts, plus extensive bibliographical references. Contains sections specifically on the senses, integrating sensory information, and theoretical frameworks for perception.](#)

Schwartz, Robert, ed. *Perception*. Malden, MA: Blackwell, 2004. [ISBN: 9780631224211]

[Contains chapters from key historical and contemporary writers on the senses in both philosophy and psychology, including Aristotle, Berkeley, Reid, Helmholtz, Koffka, Gibson,](#)

Evans, O'Shaughnessy, and Churchland, as well as more general work on theories of perception.

Stokes, Dustin, Mohan Matthen, and Stephen Biggs, eds. *Perception and Its Modalities*. Oxford: Oxford University Press, 2015. [ISBN: 9780199832811]

An excellent collection of more recent work covering a range of issues relating to the senses, multisensory perception, and crossmodal phenomena.

Psychology and Neuroscience

There is a vast and rapidly expanding scientific literature on sensory perception, the interpretation of which can be difficult and demanding for philosophers not versed in the relevant experimental methods. Most introductory psychology textbooks, however, offer a section on perception and the senses, and numerous dedicated introductions to the science of perception are readily available. These introductory textbooks are highly recommended for general background on the physiology, psychology, and neuroscience of the senses—the details of which are often underexplored (and sometimes misunderstood) in philosophical debates (see Twedt and Proffitt 2015 for further recommendation). For more advanced references, see Calvert, et al. 2004 and Stein 2012, which are very technical in places and thus may be difficult for the nonspecialist. Generally speaking, the influence of Gibson 1966 and Marr 1982 (the latter cited under [*Sensory Modalities: Vision*](#)) cannot be understated, with many psychologists following a variant of either ecological or computational approaches. Other volumes focus on space and attention across the senses (Spence and Driver 2004), developmental issues (Bremner, et al. 2012), and nonhuman senses (Hughes 1999).

Bremner, Andrew J., David J. Lewkowicz, and Charles Spence, eds. *Multisensory Development*. Oxford: Oxford University Press, 2012. [ISBN: 9780199586059]

Examines the development of the senses from early gestation to old age, with a focus on multisensory processing and integration.

Calvert, Gemma A., Charles Spence, and Barry E. Stein, eds. *The Handbook of Multisensory Processes*. Cambridge, MA: MIT Press, 2004. [ISBN: 9780262033213]

An influential collection of psychological and neuroscientific studies of perception, with dedicated sections on speech, multisensory integration, orientation, plasticity, and clinical studies. An excellent reference resource, although highly technical in places.

Gibson, James J. *The Senses Considered as Perceptual Systems*. Boston: Houghton Mifflin, 1966.

Elucidates Gibson's "ecological" theory of perception, an influential forerunner of modern embodied and enactive approaches that may be contrasted with the computational approach to sensory processing described by Marr 1982 (cited under [*Sensory Modalities: Vision*](#)). For further information, see the *Oxford Bibliographies* article "[*Ecological Psychology\[obo-9780199828340-0072\]*](#)."

Hughes, Howard C. *Sensory Exotica: A World beyond Human Experience*. Cambridge, MA: MIT Press, 1999. [ISBN: 9780262582049]

An accessible and fascinating collection that recounts the discovery of, and anatomical and physiological principles behind, a broad range of nonhuman senses, including echolocation in bats and dolphins, biological compasses, and electroperception.

Spence, Charles, and Jon Driver, eds. *Crossmodal Space and Crossmodal Attention*. Oxford: Oxford University Press, 2004. [ISBN: 9780198524878]

A collection of essays by leading scientific experts on the multimodal representation of space and the way in which this constrains spatial attention. (See also [Eilan, et al. 1993](#), cited under [*Crossmodal Phenomena: Other Crossmodal Phenomena*](#).)

Stein, Barry E., ed. *The New Handbook of Multisensory Processing*. Cambridge, MA: MIT Press, 2012. [ISBN: 9780262017121]

A comprehensive cross-section of more recent research in this area organized thematically, with each chapter written by a domain expert, and with a detailed bibliography. As with [Calvert, et al. 2004](#), this book is highly technical in places, but section-level introductions are helpful for putting the research in context.

Twdet, Elyssa, and Dennis R. Proffitt. "Perception[obo-9780199828340-0119]." In *Oxford Bibliographies in Psychology*. Edited by Dana S. Dunn. New York: Oxford University Press, 2015.

Annotated bibliography covering the neural processing of sensory information via the five Aristotelian senses. Examines the organization of sensory systems in the brain, and how these map onto perceptual experience. An excellent starting point for further reading and research.

History and Anthropology

In addition to the scientific literature (see [*Psychology and Neuroscience*](#)), there is a rich tradition of historical and anthropological work on the way in which the senses have been viewed over time by different cultures. Notable works include [Howes 1991](#) and [Classen 1993](#). See also [Howes and Classen 2013](#), as well as [Classen 2014](#), the extensive and beautifully illustrated book that illustrates the importance of the senses and sensory experience to human life and culture. Papers, book reviews, and other useful resources in the interdisciplinary field of sensory studies are available on the [**Sensory Studies: Books of Note**](#) website, edited by David Howes.

Ackerman, Diane. *A Natural History of the Senses*. New York: Random House, 1991. [ISBN: 9780394573359]

A popular and engagingly written introduction to the richness and variety of the five Aristotelian senses across different cultures and historical periods.

Classen, Constance. *Worlds of Sense: Exploring the Senses in History and across Cultures*. London: Routledge, 1993. [ISBN: 9780415101264]

Historical study examining how cross-cultural variability in the hierarchy and ordering of the senses affects our worldview.

Classen, Constance, ed. *A Cultural History of the Senses*. 6 vols. London: Bloomsbury, 2014. [ISBN: 9780857853387]

An extensive reference work written by leading historians that gives a detailed cultural history of Antiquity, the Middle Ages, Renaissance, Enlightenment, Empire, and the Modern Age, drawing on all of the senses.

Howes, David, ed. *The Varieties of Sensory Experience: A Sourcebook in the Anthropology of the Senses*. Toronto: University of Toronto Press, 1991. [ISBN: 9780802068446]

One of the first works to consider the range of sensory experience both across and within cultures, including many interesting case studies. (See also [Classen 1993](#).)

Howes, David, and C. Classen. *Ways of Sensing: Understanding the Senses in Society*. London and New York: Routledge, 2013. [ISBN: 9780415697149]

Explores the cultural, historical, and political dimensions of sensory experience across cultures and historical periods. A good starting point for further reading.

Jütte, Robert. *A History of the Senses: From Antiquity to Cyberspace*. Translated by James Lynn. Cambridge, UK: Polity, 2005. [ISBN: 9780745629582]

Charts the history of our sensory concepts, and the ways in which the senses have been regarded from Antiquity into the early 21st century.

[Sensory Studies: Books of Note](http://www.sensorystudies.org/books-of-note/)[<http://www.sensorystudies.org/books-of-note/>]. Edited by David Howes. [class:data-database]

Regularly updated bibliography of publications in the multidisciplinary field of sensory studies. The website also contains a directory of researchers and other useful resources including the

[Senses and Society](http://www.tandfonline.com/toc/rfss20/current)[<http://www.tandfonline.com/toc/rfss20/current>] journal.

INDIVIDUATING THE SENSES

The question of how many sensory modalities humans have and how they should be individuated has been discussed extensively in the philosophical literature. The introduction to [Macpherson ed. 2011](#) (pp. 3–43) provides an overview of that debate, which dates back to Aristotle who is credited with the now-commonplace idea that humans have only five senses. Although most people in the early 21st century are now fairly familiar with scientific work that identifies as many as seventeen or even thirty-three potential candidates for human senses, as the evidence presented by [Dallenbach 1939](#) demonstrates, the number of senses that humans have has been hotly disputed through the centuries. Thus it is a myth that academics have been settled on humans having only five senses. Macpherson’s “fine-grained” view is further developed in [Macpherson ed. 2015](#) and may be contrasted with the sensory pluralism of [Fulkerson 2014](#), conventionalism of [Richardson 2014](#), and the “two-concept” view of [Matthen 2015](#) (cf. [Gibson 1966](#) [cited under *[Anthologies and Reference: Psychology and Neuroscience](#)]*) who distinguishes between “sensory” and “perceptual” modalities). For further discussion of the interaction between the philosophical individuation question and the physical sciences, see [Casati, et al. 2015](#).

Casati, Roberto, Jérôme Dokic, and François Le Corre. “Distinguishing the Commonsense Senses.” In *Perception and Its Modalities*. Edited by Dustin Stokes, Mohan Matthen, and Stephen Biggs, 462–479. Oxford: Oxford University Press, 2015. [ISBN: 9780199832811] Examines the four criteria—qualia, content, stimulus, and sensory organ—that are traditionally used to differentiate the senses, employing a series of thought experiments designed to establish the contribution of “qualia,” or phenomenal character, to the individuation of the senses.

Dallenbach, Karl M. “Pain: History and Present Status.” *American Journal of Psychology* 52 (1939): 331–347.

Although focusing on pain, Dallenbach presents a historical overview of philosophical considerations about which senses humans have, characterizing the history of pain as a three-way battle between whether (1) it is a distinct sensory modality, (2) it arises from the intensive stimulation of other modalities, or (3) it is a felt quality or affective state.

Fulkerson, Matthew. “Rethinking the Senses and Their Interactions: The Case for Sensory Pluralism.” *Frontiers in Psychology* 5 (2014): 1–14.

Defends a form of pragmatism, or “pluralism,” about the distinction between the senses according to which there is no single privileged way of individuating sensory modalities, which do not form a unified natural kind. Instead, Fulkerson takes the relevant individuation criteria to be relative to explanatory goals.

Macpherson, Fiona. “The Space of Sensory Modalities.” In *Perception and Its Modalities*. Edited by Dustin Stokes, Mohan Matthen, and Stephen Biggs, 432–461. Oxford: Oxford University Press, 2015. [ISBN: 9780199832811]

Develops ideas presented in the introduction to Macpherson ed. 2011 (pp. 3–43) to provide a fine-grained account of sensory individuation in terms of a multi-dimensional “space” of sense modality-types.

Macpherson, Fiona, ed. *The Senses: Classical and Contemporary Perspectives*. New York: Oxford University Press, 2011. [ISBN: 9780195385960]

A wide-ranging collection that includes classic works by Aristotle, H. P. Grice, John Heil, Brian L. Keeley, J. W. Roxbee Cox, among others, in addition to new contributions from Richard Gray, A. D. Smith, Matthew Nudds, and others. The introduction provides a helpful overview of the philosophical issues surrounding the individuation of the senses and offers a good starting point for further reading.

Matthen, Mohan. “The Individuation of the Senses.” In *The Oxford Handbook of Philosophy of Perception*. Edited by Mohan Matthen, 567–586. Oxford: Oxford University Press, 2015. [ISBN: 9780199600472]

Defends a distinction between the scientific and folk conceptions of what constitutes a sensory modality, both of which Matthen argues are based on the central notion of “information pickup” (cf. Gibson 1966, cited under *Anthologies and Reference: Psychology and Neuroscience*).

Richardson, Louise. “Non Sense-Specific Perception and the Distinction between the Senses.” *Res Philosophica* 91 (2014): 215–239.

Examines how the prevalence of multisensory perception bears on the individuation of sensory modalities, arguing that this leaves room for the notions of the “senses as systems” and “senses as capacities” (cf. Nudds in Macpherson ed. 2011, pp. 311–340).

SENSORY MODALITIES

Given the lack of consensus over how to individuate the senses (see *Individuating the Senses*), any attempt at a taxonomy will be contentious, and this section is no exception. Included here are the five exteroceptive “Aristotelian” senses: smell or *Olfaction*, *Taste and Flavor*, *Audition*, *Touch*, and *Vision*, with separate sections for various forms of interoception (see *Bodily Awareness*) include position, movement, and internal condition of our bodies; awareness of body position (proprioception); awareness of self-movement (kinesthesia); and balance and acceleration (the vestibular system). *Pain* is sometimes also regarded as a sensory modality. More controversial cases, including the sense of agency, temporal passage, and pheromone detection, are grouped under *Other Human Senses*, with a final section on *Nonhuman Senses*. Each section highlights works that deal with the particular characteristics of, and issues relevant to, the specific sense in question. A notable exception is *Vision*, the literature on which is too extensive to give a representative sample. This is partly because philosophers have—somewhat misleadingly in the view of the authors of this article—taken vision to be characteristic of all of the senses. This section therefore focuses instead on the variety and dominance of visual experience. For comparisons between sensory modalities, see *Contrasting the Senses*.

Olfaction

The distinctiveness of olfaction, along with how it differs from vision, are introduced by [Lycan 2000](#), with [Batty 2010](#) providing an excellent survey of the philosophical issues concerning the nature of odors and olfactory experience (see also the *Oxford Bibliographies* article by Batty [“*Olfaction\[obo-9780195396577-0333\]”](#)). [Smith 2015](#) discusses the senses of smell, taste, and the often-neglected trigeminal system—collectively referred to as the “chemical senses”—along with the interactions among these and other senses that underpin flavor perception (see [*Taste and Flavor*](#)), of which retronasal olfaction is a major component. Smith also considers whether orthonasal and retronasal olfaction should be regarded as the same or distinct modalities—an issue brought to prominence in the psychological literature by [Rozin 1982](#). [Richardson 2013](#) argues that, like vision, orthonasal olfaction (“sniffing”) is exteroceptive rather than interoceptive, whereas [Mizrahi 2013](#) defends a view of odors according to which they are properties of “stuffs.” [Young, et al. 2014](#) argues that, despite the relative complexity and number of dimensions of olfactory discrimination, it is possible to apply quality-space theory to the sense of smell. For loss of olfaction, see [Tafalla 2013](#), cited under [*Sensory Enhancement and Deficits: Sensory Loss*](#).

Batty, Clare. “Olfactory Experience.” *Philosophy Compass* 5 (2010): 1137–1156.

A two-part review article that provides a comprehensive overview of the philosophical issues relating to olfaction and the challenges that this presents for representational views of olfactory experience, including Batty’s view. The first, “[The Content of Olfactory Experience](#)” (pp. [1137–1146](#)), deals with the content of olfactory experiences, and the second, “[Objects and Properties](#)” (pp. [1147–1156](#)), focuses on the nature of olfactory objects and olfactory properties.

Lycan, William G. “The Slighting of Smell.” In *Of Minds and Molecules: New Philosophical Perspectives on Chemistry*. Edited by Nalini Bhushan and Stuart Rosenfeld, 273–289. New York: Oxford University Press, 2000.

Argues that olfaction differs significantly from vision in various key respects and that the history of philosophy of perception would have taken a very different path had theorists focused on the former instead of the latter.

Mizrahi, Vivian. “Sniff, Smell, and Stuff.” *Philosophical Studies* 171 (2013): 233–250.

Debunks the idea that smell is informationally poor or otherwise impoverished compared to the other senses (cf. [Lycan 2000](#) and [Batty 2010](#)), and defends a view of odors according to which smells are not particular objects, but properties of “stuffs,” i.e., substances that are most naturally referred to using mass nouns, as opposed to count nouns.

Richardson, Louise. “Sniffing and Smelling.” *Philosophical Studies* 162 (2013): 401–419.

Argues that orthonasal olfaction (“sniffing”) is exteroceptive, i.e., seems to be of objects that are external to the body, and that the act of inhaling odors into the body makes a distinctive contribution to the phenomenal character of olfactory experience.

Rozin, Paul. “‘Taste–Smell’ Confusions and the Duality of the Olfactory Sense.” *Perception & Psychophysics* 31 (1982): 397–401.

This influential psychology article claims that olfaction is a “dual modality” due to its role in both smell and “taste,” i.e., flavor perception (cf. [Gibson 1966](#), cited under [*Anthologies and Reference: Psychology and Neuroscience*](#)). Predicts qualitative differences between the phenomenal character and representational content of orthonasal and retronasal olfaction, although whether these are borne out by the empirical evidence is controversial (see [Smith 2015](#) for a discussion of this).

Smith, Barry C. “The Chemical Senses.” In *The Oxford Handbook of Philosophy of Perception*. Edited by Mohan Matthen, 314–352. Oxford: Oxford University Press, 2015. [ISBN: 9780199600472]

Excellent empirically informed overview of the philosophical issues relating to, and distinction between, smell; taste and flavor perception, including the distinction between orthonasal and retronasal olfaction; and contributions made by the nose, tongue, and somatosensory and trigeminal systems to the multimodal experience of flavor.

Watson, Lyall. *Jacobson’s Organ and the Remarkable Nature of Smell*. London: Penguin, 1999. [ISBN: 9780713993479]

Examines the role of smell and pheromone perception in humans, plants, and animals, in particular, whether the eponymous “Jacobson’s Organ,” or vomeronasal organ (VNO), is functional in humans (see [*Other Human Senses*](#)). Also examines the role of smell in memory formation and social interaction.

Young, Benjamin D., Andreas Keller, and David Rosenthal. “*Quality-Space Theory in Olfaction[<https://www.frontiersin.org/articles/10.3389/fpsyg.2014.00001/full>]*.” *Frontiers in Psychology* 5 (2014).

Applies quality-space theory, a theory of qualitative character, to olfaction, describing the challenges to the construction of an olfactory “quality space”—generally thought to have a large number of dimensions—and how these might be met.

Taste and Flavor

[Smith 2013](#) provides a concise overview of the philosophical issues, including the distinction between the “taste” perception in the strict scientific sense, which originates at the tongue, and “flavor,” which [Spence, et al. 2015](#) believes to be a multisensory experience involving sensory inputs from multiple modalities—taste, smell, trigeminal, touch, audition, and even vision. The precise taxonomy of the human taste, smell, and flavor senses is, however, disputed, with theorists differing over whether “taste” should be taken to involve an olfactory component ([Richardson 2013](#), [Smith 2013](#), and [Smith 2015](#)), or whether flavor should itself be considered a distinctive modality ([Auvray and Spence 2008](#)). A detailed discussion of the biological and psychological basis of flavor perception may be found in [Stevenson 2009](#), with the implications of the multimodality of flavor perception for dining and gastronomy discussed by [Spence and Piqueras-Fiszman 2014](#). For general background on the importance of food and flavor to human experience, see [Korsmeyer 2005](#).

Auvray, Malika, and Charles Spence. “The Multisensory Perception of Flavor.” *Consciousness and Cognition* 17 (2008): 1016–1031.

Accessible review article that presents scientific evidence for a variety of interactions between the various chemical senses. This builds on work by [Gibson 1966](#) (cited under [*Anthologies and Reference: Psychology and Neuroscience*](#)) to posit a multimodal “flavor” modality which draws on a variety of perceptual inputs. (See also [Spence, et al. 2015](#) and [Richardson 2013](#).)

Korsmeyer, Carolyn, ed. *The Taste Culture Reader: Experiencing Food and Drink*. Oxford: Berg, 2005. [ISBN: 9781845200619]

A wide-ranging collection that examines the importance of food and flavor to human experience and society, with contributions from anthropology, sociology, history, philosophy, and science. Good background reading.

Richardson, Louise. “Flavour, Taste and Smell.” *Mind and Language* 28 (2013): 322–341.

Argues that “non-naturalism”—the view that human senses, and taste and smell in particular, are individuated according to an everyday conception of these in a way that does not carry any empirical commitments that are correctable by the sciences—remains a viable option. See also Nudds in Macpherson 2011 (pp. 311–340, cited under *Individuating the Senses*) and the “Symposium on Louise Richardson’s ‘Flavour, Taste and Smell’” on the website *The Brains Blog*[<http://philosophyofbrains.com/2013/06/06/louise-richardson-synpo.aspx>]*.

Smith, Barry C. “Taste, Philosophical Perspectives.” In *Encyclopedia of the Mind*. Vol. 2. Edited by Harold Pashler, 731–735. San Diego, CA: SAGE, 2013. [ISBN: 9781452257044]

Encyclopedia entry that provides an overview of key issues in the philosophy of taste and flavor, including whether tastes are sensations, properties, or substances; the temporal dimension of tasting; and the nature of flavors and flavor perception. A good starting point for further reading. (See also Smith 2015.)

Smith, Barry C. “The Chemical Senses.” In *The Oxford Handbook of Philosophy of Perception*. Edited by Mohan Matthen, 314–352. Oxford: Oxford University Press, 2015. [ISBN: 9780199600472]

Empirically informed overview of the philosophical issues surrounding the chemical senses of taste, smell, and flavor. Sections that relate specifically to taste and flavor include the nature of flavors and flavor experiences, the contribution of the tongue to tasting flavors, and a discussion on whether tastes are sensations. (See also Smith 2013 and Spence, et al. 2015.)

Spence, Charles, Malika Auvray, and Barry Smith. “Confusing Tastes with Flavours.” In *Perception and Its Modalities*. Edited by Dustin Stokes, Mohan Matthen, and Stephen Biggs, 247–274. Oxford: Oxford University Press, 2015. [ISBN: 9780199832811]

Further develops the philosophical implications of ideas presented by Auvrey and Spence 2008, including details of the “referral” of olfactory stimuli to the mouth, and the role of attention, to defend a distinction between taste and flavor perception when the latter involves contributions from many kinds of stimuli. (See also Smith 2015.)

Spence, Charles, and Betina Piqueras-Fiszman. *The Perfect Meal: The Multisensory Science of Food and Dining*. Chichester, UK: Wiley-Blackwell, 2014. [ISBN: 9781118490822]

Provides a psychological perspective not only of taste and smell, but also of how all of our senses contribute to the multisensory experience of eating and dining in a cultural context. A sourcebook for those interested in the scientific research behind multisensory dining and molecular gastronomy.

Stevenson, Richard J. *The Psychology of Flavour*. Oxford: Oxford University Press, 2009. [ISBN: 9780199539352]

Extensive treatment of the psychology and biology of flavor-perception, including its function, the structure of the “flavor system,” interactions with memory and learning, and flavor hedonics.

Audition

O’Callaghan 2014 and Nudds 2015 offer detailed overviews of the central questions in the philosophy of audition, including the objects and contents of auditory experience and the metaphysics of sounds (cf. Pasnau 1999, Matthen 2010, and Kulvicki 2017). O’Callaghan 2007 details the author’s event-based view and contrasts it with those of Casati and Dokic 1994, which locates sounds at their sources, and Nudds and O’Callaghan 2010, which offers a wide-ranging collection of recent essays relating to auditory, music, and speech perception (see also chapter 25 on “Speech Perception” and chapter 26 on “Musical Perception” in Matthen 2015, cited under

[*Anthologies and Reference: Philosophy*](#)). The biological and psychological mechanisms that underpin human hearing and auditory processing are relatively well understood and are described in detail in [Bregman 1990](#), a highly influential theory of auditory scene analysis (see chapter 4, “Sounds and Space,” in [Nudds and O’Callaghan 2009](#) for philosophical commentary). The spatial characteristics of auditory experience, however, remain controversial, and the perception of auditory space via reverberation effects is discussed by [Young 2017](#). (See also [Pasnau 1999](#).) Bregman, Albert S. *Auditory Scene Analysis: The Perceptual Organization of Sound*.

Cambridge, MA: MIT Press, 1990. [ISBN: 9780262022972]

A detailed and wide-ranging scientific treatment of the human auditory system, covering psychoacoustics, speech and music perception, and computer modeling. Although somewhat technical, chapters 1 through 4 are particularly useful for philosophers wishing to gain a detailed understanding of the mechanisms that underlie auditory processing.

Casati, Roberto, and Jérôme Dokic. *La philosophie du son*. Nîmes, France: Chambon, 1994. [ISBN: 9782877111096]

Defends the view that sounds are events that happen to material objects and thus are spatially located at their sources. In the authors’ view, auditory experiences can represent both sounds and movement, but do not represent sounds as moving. Rather, they are represented as being veridically located at their origins (cf. [O’Callaghan 2007](#) and [Nudds 2015](#)). An English translation is available via [*the HAL open archive\[https://hal.archives-ouvertes.fr/\]*](#).

Kulvicki, John. “Auditory Perspectives.” In *Current Controversies in Philosophy of Perception*. Edited by Bence Nanay, 83–94. New York and London: Routledge, 2017. [ISBN: 9781138840072]

Argues against the widespread view that sounds are the objects of auditory experience, which renders audition perceptually indirect in a way that is disanalogous to vision. Instead, drawing on an analogy with Thomas Reid’s notion of “visible figure,” Kulvicki argues that sounds should be regarded as the “audible profiles” of objects, split from their sources only at the level of properties rather than being distinct objects in their own right (cf. [Pasnau 1999](#)).

Matthen, Mohan. “On the Diversity of Auditory Objects.” *Review of Philosophy and Psychology* 1 (2010): 63–89. [doi:10.1007/s13164-009-0018-z]

Defends a view of audition according to which humans directly hear not only sounds, but also “composites” of sounds, including “melodies, harmonies, sequences of phonemes, individual voices,” (p. 63) and so on. Consequently, according to Matthen, the objects of auditory experience are both non-heterogenous and non-atomistic in the sense that sounds “have no priority from the perspective of audition” (ibid.) over their composites.

Nudds, Matthew. “Audition.” In *The Oxford Handbook of Philosophy of Perception*. Edited by Mohan Matthen, 274–293. Oxford: Oxford University Press, 2015. [ISBN: 9780199600472]

A good overview of some of the fundamental questions in the philosophy of audition. Focuses on the distinction between hearing sounds, and hearing the objects and events that produce them. Also touches on the metaphysical nature of sounds, event-based views of sounds, and the representational content of auditory experiences.

Nudds, Matthew, and Casey O’Callaghan, eds. *Sounds and Perception: New Philosophical Essays*. Oxford: Oxford University Press, 2009. [ISBN: 9780199282968]

An excellent collection of recent essays on auditory perception covering, among others, the nature of auditory objects, event-based theories of sounds and audition, the perception of spatial location, the motor theory of speech perception, and whether a person can “hear” silences.

O’Callaghan, Casey. *Sounds: A Philosophical Theory*. Oxford: Oxford University Press, 2007. [ISBN: 9780199215928]

Offers a detailed account of the metaphysics of sound, hearing, and auditory experience according to which sounds are events located at or near their sources and include the medium of transmission. O’Callaghan argues that this provides the best account of a diverse range of auditory phenomena, including echoes, reverberation and Doppler effects, and defends a robustly multisensory approach to auditory and other sense perception.

O’Callaghan, Casey. “*Auditory

Perception[<http://plato.stanford.edu/archives/sum2014/entries/perception-auditory/>]*.” In *The Stanford Encyclopedia of Philosophy*. Edited by Edward N. Zalta, 2014.

A good starting point for further reading, with an extensive bibliography covering the objects and contents of auditory perception, the analogy between sound and color, different forms of auditory perception including speech and musical or “acousmatic” listening, and auditory crossmodal phenomena, such as the McGurk effect in which visual stimuli seemingly affect the sounds which are “heard”.

Pasnau, Robert. “What Is Sound?” *The Philosophical Quarterly* 49 (1999): 309–324.

An extended discussion of the metaphysics of sound and auditory experience in which Pasnau argues that there is an incoherence in our ordinary conception of sounds, which are held to be both sensible properties of objects as well as objects in their own right. According to Pasnau, the latter renders the spatial aspect of auditory experiences illusory and thus should be rejected, rendering audition both perceptually direct and capable of veridicality (cf. Kulvicki 2017).

Young, Nick. “Hearing Spaces.” *Australasian Journal of Philosophy* 95 (2017): 242–255.

[doi:10.1080/00048402.2016.1164202]

A stimulating article on the auditory perception of space that argues humans perceive the size and shape of acoustic spaces on the basis of their reverberant characteristics. Young rejects alternative accounts that treat reverberations—an often-neglected feature of auditory stimuli—as sounds in their own right, echoes, or properties of other sounds, respectively (cf. Richardson 2010, cited under *Sensory Modalities: Vision*, on the perception of visual space).

Touch

Fulkerson 2016 and Vignemont and Massin 2015 provide an overview of the philosophical issues surrounding the sense of touch and also discuss its relation to bodily awareness. Fulkerson 2014 offers an in-depth empirically informed treatment of touch and also defends the idea that touch and its submodalities of pressure, texture, temperature, and various forms of affective touch should be considered a single unified sensory modality (see also Fulkerson 2014, cited under *Individuating the Senses*). Lederman and Klatzky 2009 gives further details of the neurological basis of touch and the nature of haptic touch, and Gallace and Spence 2014 considers its interaction with other sensory modalities. O’Shaughnessy 1989 gives an influential account of the phenomenology of touch, and his ideas concerning the mediating role of bodily sensations are further developed by Martin 1992 and Richardson 2011. (See also Martin 1993, cited under *Bodily Awareness*.)

Fulkerson, Matthew. *The First Sense: A Philosophical Study of Human Touch*. Cambridge, MA: MIT Press, 2014. [ISBN: 9780262019965]

An extensive, empirically informed treatment of the sense of touch. Defends the view that touch is a single sensory modality and that “exploratory procedures” play a central role in both unifying and differentiating touch from other senses. See also Fulkerson’s contributions to

[*The Brains Blog](http://philosophyofbrains.com/category/books/matthew-fulkerson-the-first-sense/)[\[http://philosophyofbrains.com/category/books/matthew-fulkerson-the-first-sense/\]](http://philosophyofbrains.com/category/books/matthew-fulkerson-the-first-sense/).*.

Fulkerson, Matthew. “*Touch[\[http://plato.stanford.edu/archives/spr2016/entries/touch/\]](http://plato.stanford.edu/archives/spr2016/entries/touch/).*” In *The Stanford Encyclopedia of Philosophy*. Edited by Edward N. Zalta, 2016.

Introduces the different types of touch—haptic, cutaneous, and thermal awareness—with a detailed discussion of whether touch is multisensory, its relation to the other senses and to action, and the nature of tangible qualities. A good starting place for further reading with many useful references.

Gallace, Alberto, and Charles Spence. *In Touch with the Future: The Sense of Touch from Cognitive Neuroscience to Virtual Reality*. Oxford: Oxford University Press, 2014. [ISBN: 9780199644469]

A cognitive neuroscientific account of tactual perception, its neurological basis, and its role in interpersonal interactions, sex, eating, technology, and marketing. Emphasizes the multisensory context and nature of touch (cf. [Fulkerson 2014](#)).

Lederman, S. J., and R. L. Klatzky. “Haptic Perception: A Tutorial.” *Attention, Perception, & Psychophysics* 71 (2009): 1439–1459. [doi:10.3758/APP.71.7.1439]

A comprehensive tutorial review of the mechanisms of haptic touch, which receives inputs from both tactile and kinesthetic subsystems, thereby enabling active exploration of objects. In addition to being an excellent starting point and source of further reading about the distinction between tactile and active touch, the authors also discuss the existence of “what” and “where” channels for touch, interactions between touch and vision, and affective touch. (See also [Fulkerson 2014](#) and [Gibson 1988](#) [the latter cited under *Crossmodal Phenomena: Other Crossmodal Phenomena*].)

Martin, Michael. “Sight and Touch.” In *The Contents of Experience*. Edited by Tim Crane, 196–215. New York: Cambridge University Press, 1992. [ISBN: 9780521173179]

In the context of a comparison between the experience of space across visual and tactile modalities, Martin presents an influential account of the phenomenology of touch that rules out the existence of a “tactual field,” analogous to the visual field. (See also [Richardson 2011](#) and [Martin 1993](#) [the latter cited under *Bodily Awareness*].)

O’Shaughnessy, Brian. “The Sense of Touch.” *Australasian Journal of Philosophy* 67 (1989): 37–58.

An extremely rich paper that anticipates many of the current debates about touch.

O’Shaughnessy offers a nuanced account of the phenomenology of touch arguing that, uniquely among the senses, touch and bodily awareness draw on “innate knowledge” and so are epistemically interdependent.

Richardson, Louise. “Bodily Sensation and Tactile Perception.” *Philosophy and Phenomenological Research* 86 (2011): 134–154.

Develops the account by [O’Shaughnessy 1989](#) of the relation between bodily sensations and touch, arguing that such sensations both “mediate” and suffice for a sense of touch, although not in a way that renders tactual perception epistemically indirect. (See also [Martin 1992](#).)

Vignemont, Frédérique de, and Olivier Massin. “Touch.” In *The Oxford Handbook of Philosophy of Perception*. Edited by Mohan Matthen, 294–313. Oxford: Oxford University Press, 2015. [ISBN: 9780199600472]

Provides an overview of the philosophical literature on touch, with extensive discussion of its relation to bodily awareness, including proprioception, and the felt location of tactile sensations as explained by “body template” and “body map” theories of touch.

Bodily Awareness

Closely related to, but distinct from, the sense of touch are the collection of sensory modalities that enables us to determine the position, movement, and internal condition of our bodies. These various forms of what has become collectively known as “bodily awareness” (see [Vignemont 2015](#)) include proprioception (perception of body position), kinesthesia (bodily movement), the vestibular system (balance and acceleration), nociception (pain), and homeostatic regulation of bodily states (e.g., hunger and thirst). [Ritchie and Carruthers 2015](#) argues that each of these should be considered distinct sensory modalities, rather than a single unified body-sense, although the divisions are controversial (see [*Individuating the Senses*](#)). [Armstrong 1962](#) distinguishes between “bodily sensations,” which have spatial locations, and “bodily feelings,” which do not, whereas [Martin 1993](#) argues that the felt extent of the body coincides with the boundaries within which bodily sensations are perceived as being located. [Richardson 2015](#) (cited under [*Contrasting the Senses*](#)) discusses the contrast between bodily awareness and other sensory modalities, and [Cole 2016](#) (cited under [*Sensory Enhancement and Deficits: Sensory Loss*](#)) covers the loss of bodily awareness.

Armstrong, David. *Bodily Sensations*. London: Routledge & Kegan Paul, 1962.

A short but influential book that defends a perceptual account of bodily sensations, including pain, bodily awareness, and various forms of touch. Introduces the distinction between “bodily sensations,” which are located in space, and “bodily feelings,” which are not, as well as “transitive” sensations that have a distinct object versus “intransitive” sensations.

Goldberg, Jay M., Victor J. Wilson, Kathleen E. Cullen, et al. *The Vestibular System: A Sixth Sense*. Oxford: Oxford University Press, 2012. [ISBN: 9780195167085]

A detailed scientific work on the structure, physiology, and neurophysiology of the vestibular system, which is responsible for the sense of balance, acceleration, and deceleration. Although pivotal to everyday life, this sense has long been neglected by philosophers, and its contributions to experience and interactions with each of the other senses remain open and interesting questions.

Martin, Michael. “Sense Modalities and Spatial Properties.” In *Spatial Representation*. Edited by Naomi Eilan, Rosaline McCarthy, and Bill Brewer, 206–218. Oxford: Blackwell, 1993. [ISBN: 9780631183556]

A rich and influential account according to which bodily awareness, although not a fully fledged sensory modality, is intrinsically spatial, with the felt extent of the body coinciding with the spatial boundaries within which bodily sensations are perceived as being located. The latter claim, however, is subject to potential counterexamples (see [Vignemont 2015](#), section 5.2.1, “The Spatial Conception,” for a discussion of this).

Ritchie, J. Brendan, and Peter Carruthers. “The Bodily Senses.” In *The Oxford Handbook of Philosophy of Perception*. Edited by Mohan Matthen, 353–370. Oxford: Oxford University Press, 2015. [ISBN: 9780199600472]

A good, although brief, introduction to the three main classes of bodily awareness: interoception (internal monitoring of bodily organs), the vestibular system (balance and acceleration), and proprioception (bodily position and movement, or kinesthesia). The authors argue that each of these classes is constituted by a collection of distinct sensory modalities rather than being a single unified sense.

Vignemont, Frédérique de. “*Bodily Awareness[<http://plato.stanford.edu/archives/win2015/entries/bodily-awareness/>]*.” In *The Stanford Encyclopedia of Philosophy*. Edited by Edward N. Zalta, 2015.

An extensive overview of the phenomenology and epistemology of bodily awareness (awareness of the positions and movements of one's body) and bodily ownership (the sense of "mine-ness" that normally accompanies it). These can become dissociated in conditions such as somatoparaphrenia ("alien hand syndrome") and anosognosia for hemiplegia, in which subjects experience apparent bodily movement even though paralyzed.

Pain

As documented by [Dallenbach 1939](#) (cited under [*Individuating the Senses*](#)), pain occupies a somewhat unusual place in the philosophy of perception. Considered by some philosophers to be a paradigm case of mere sensation rather than perception proper and by others to be a submodality of touch, the sensation of pain (or painfulness) should be distinguished from nociception—the sensory system responsible for the detection of harmful or noxious stimuli—marking an asymmetry with pleasure, which is not normally considered a sensory modality (cf. [Lederman and Klatzky 2009](#), cited under [*Sensory Modalities: Touch*](#), on affective touch). For extensive bibliographical references and discussion, see [Bain 2015](#) and [Aydede 2013](#), both of which provide overviews of the main theories of pain, including intentionalism ([Tye 1995](#)), evaluativism ([Bain 2015](#)), and imperativism ([Klein 2015](#)). The historically popular, but now largely abandoned, "intensive theory of pain" is defended by [Gray 2014](#). [Corns 2017](#) gives a comprehensive and in-depth treatment of the central issues in the philosophy and science of pain, whereas [Melzack and Wall 2008](#) is the definitive reference work for the psychology and physiology of pain. [Grahek 2007](#) provides an accessible and engaging introduction to the philosophical issues, including the relevance of various pathologies, such as pain asymbolia, that have motivated a resurgence of interest in this topic.

Aydede, Murat. "[*Pain](#)[<http://plato.stanford.edu/archives/spr2013/entries/pain/>]*." In *The Stanford Encyclopedia of Philosophy*. Edited by Edward N. Zalta, 2013.

[A comprehensive and accessible overview of the philosophy of pain. Introduces perceptual, representational, and eliminativist theories of pain along with some of the leading representational views—intentionalism, evaluativism, and imperativism—plus an extensive bibliography and links to other useful resources.](#)

Bain, David. "[*Pain](#)[[obo-9780195396577-0280](#)]*." In *Oxford Bibliographies in Philosophy*. New York: Oxford University Press, 2015. [class:dataSetItem-database]

[A detailed and extensive bibliography of leading philosophical and scientific works on pain. Includes sections on the nature and phenomenology of pain, its spatial characteristics, affective dimension, perceptual and representational views—including some of Bain's other work that defends a form of evaluativism—and pain disorders, such as asymbolia.](#)

Corns, Jennifer, ed. *Routledge Handbook of Philosophy of Pain*. Abingdon, UK: Routledge, 2017. [ISBN: 9781138823181]

[An updated collection of essays on the philosophy, neuroscience, and psychology of pain. Containing contributions from leading subject experts and divided into sections on the nature of pain and its theoretical and practical implications, this volume provides a comprehensive introduction and reference to the philosophy and science of pain.](#)

Grahek, Nikola. *Feeling Pain and Being in Pain*. 2d ed. Cambridge, MA: MIT Press, 2007. [ISBN: 9780262072830]

[Excellent and highly readable introduction to the philosophy of pain. The first edition, published in 2001, was partly responsible for highlighting clinical evidence for the](#)

dissociability of pain from its affective components (e.g., unpleasantness) in conditions such as pain asymbolia, generating a resurgence of philosophical interest in the topic.

Gray, Richard. "Pain Perception and the Sensory Modalities: Revisiting the Intensive Theory." *Review of Philosophy and Psychology* 5 (2014): 87–101.

Argues against sensory or perceptual accounts of pain in favor of the historically popular "intensive theory of pain," also discussed by [Dallenbach 1939](#) (cited under [*Individuating the Senses*](#)), in which pains represent the excessive stimulation of sense-organs.

Klein, Colin. *What the Body Commands: The Imperative Theory of Pain*. Cambridge, MA: MIT Press, 2015. [ISBN: 9780262029704]

A sophisticated defense of the imperative theory of pain, according to which pains are "intrinsically motivating" sensations, the contents of which have the form of a command, thereby explaining their close links with action. See [Bain 2015](#) for further reading and alternative views, including Bain's evaluative account.

Melzack, Ronald, and Patrick D. Wall. *The Challenge of Pain*. 2d ed. London: Penguin, 2008. [ISBN: 9780140256703]

A classic reference work and comprehensive introduction to the science of pain. Parts 1 and 2 focus on the psychology and physiology of pain, and Part 3 presents various theories of pain, including Melzack and Wall's famous "gate-control" mechanism. Part 4 addresses methods of pain control. Essential reading for those wishing to engage with the physiological and psychological literature on pain.

Tye, Michael. "A Representational Theory of Pains and Their Phenomenal Character." *Philosophical Perspectives* 9 (1995): 223–239.

Defends a form of intentionalism about pain according to which pains represent bodily damage, with their phenomenal character supervening on this representational content. An influential early exponent of the perceptual-representational approach, Tye has since switched to endorsing evaluatism.

Vision

As noted in the introduction to [*Sensory Modalities*](#), philosophers writing about perception have tended to focus primarily, and sometimes exclusively, on vision. [Hilbert 2015](#) provides a comprehensive overview on vision. Other works highlight some of the distinctive features of vision, such as the role of color ([Macpherson 2015](#)), the experience of empty space ([Richardson 2010](#)), the representation of high-level properties in visual experience ([Siegel 2006](#)), the diversity of vision ([Hughes, et al. 2015](#)), and the dominance of vision over other sensory modalities ([Stokes and Biggs 2015](#)). In the psychological literature, the historical influence of [Gibson 1979](#) and [Marr 1982](#) cannot be overstated, and both provide useful theoretical background for understanding contemporary scientific debates. The varieties of animal vision are discussed by [Lazareva, et al. 2012](#) (see also [*Nonhuman Senses*](#)). For representation of space in the visual system, see Part V of [Eilan, et al. 1993](#) (pp. 269–399), cited under [*Crossmodal Phenomena: Other Crossmodal Phenomena*](#). For loss of vision, see [Magee and Milligan 1998](#), cited under [*Sensory Enhancement and Deficits: Sensory Loss*](#).

Gibson, James J. *The Ecological Approach to Visual Perception*. Boston: Houghton Mifflin, 1979. [ISBN: 9780395270493]

A classic and highly influential work in perceptual psychology which applies the ecological approach to vision presented in [Gibson 1966](#) (cited under [*Anthologies and Reference: Psychology and Neuroscience*](#)). In contrast to the computational approach of [Marr 1982](#),

Gibson emphasizes the embodied and embedded nature of human and animal vision, along with its close links with action, introducing the notions of the “ambient optic array,” optic flow, information pickup, and the theory of affordances.

Hilbert, David R. “Vision.” In *The Oxford Handbook of Philosophy of Perception*. Edited by Mohan Matthen, 257–273. Oxford: Oxford University Press, 2015. [ISBN: 9780199600472]
Provides an excellent overview of the philosophical and scientific issues concerning visual perception, covering basic optics, visual processing, and the neuropsychology of vision, as well as the objects and contents of visual experience and vision’s relation to action. A good starting point for further reading.

Hughes, Howard C., Robert Fendrich, and Sarah E. Streeter. “The Diversity of Human Visual Experience.” In *Perception and Its Modalities*. Edited by Dustin Stokes, Mohan Matthen, and Stephen Biggs, 297–326. Oxford: Oxford University Press, 2015. [ISBN: 9780199832811]
An accessible paper that provides an overview of some diverse visual phenomena and sensory deficits, including gist perception, change blindness, blindsight, and the plasticity of the visual cortex. The authors highlight the interplay between externally generated sensory signals and internal processes, including the deployment of attention and observer expectancies, in generating visual experience.

Lazareva, Olga F., Toru Shimizu, and Edward A. Wasserman, eds. *How Animals See the World: Comparative Behavior, Biology, and Evolution of Vision*. New York: Oxford University Press, 2012. [ISBN: 9780195334654]

A detailed and comprehensive anthology on the science of animal vision across a wide variety of species, including insects, spiders, fish, birds, and primates. Draws on the latest neuroscience, cognitive science, and behavioral science, with sections on various aspects of perceptual processing, object perception, attention, and the evolution of the visual system.

Macpherson, Fiona. “The Structure of Experience, the Nature of the Visual, and Type 2 Blindsight.” *Consciousness and Cognition* 32 (2015): 104–128.

Argues that, contrary to Aristotle and some 21st-century philosophers, color is not a necessary, or “structural,” feature of visual experience. If correct, this has implications for whether certain forms of blindsight and other novel cases should be classified as involving a kind of visual experience, albeit one that does not include the experience of color.

Marr, David. *Vision*. New York: Freeman, 1982. [ISBN: 9780716715672]

In contrast to [Gibson 1979](#), Marr considers vision to be an essentially computational process in which information is processed via a series of modules, each of which outputs representations of the external world ranging from elementary visual features to a “2.5-D sketch,” and, ultimately, 3-D objects. Marr’s framework, which posits distinct computational, algorithmic, and implementation levels of analysis, remains highly influential in the fields of perceptual science and artificial intelligence.

Richardson, Louise. “Seeing Empty Space.” *European Journal of Philosophy* 18 (2010): 227–243.

Argues that there is a link between “seeing” the empty space between objects, as opposed to seeing those objects themselves, and the existence of a visual field, i.e., a spatially structured region or array that is bounded by our sensory limitations. (See also [Martin 1992](#), cited under [*Touch*](#), and [Young 2017](#), cited under [*Audition*](#).)

Siegel, Susanna. “Which Properties Are Represented in Perception?” In *Perceptual Experience*. Edited by Tamar S. Gendler and John Hawthorne, 481–503. New York: Oxford University Press, 2006. [ISBN: 9780199289769]

Considers whether properties other than shape, color, illumination, and motion are represented by visual experiences. Assuming a representational view of experience, Siegel argues that it is plausible that some visual experiences represent “kind” properties, such as *being a pine tree*, that make a phenomenological difference to their qualitative character.

Stokes, Dustin, and Stephen Biggs. “The Dominance of the Visual.” In *Perception and Its Modalities*. Edited by Dustin Stokes, Mohan Matthen, and Stephen Biggs, 350–378. Oxford: Oxford University Press, 2015. [ISBN: 9780199832811]

Examines one way in which vision may be considered special among the senses in terms of its dominance over audition, touch, and other modalities in a range of psychologically and epistemically significant ways. Includes a discussion of multisensory illusions, such as the McGurk effect (see O’Callaghan 2014, cited under **Sensory Modalities: Audition**), multisensory integration, and mental imagery.

Other Human Senses

In addition to the five Aristotelian senses, plus pain and various forms of bodily awareness, a wide variety of other, often-controversial sensory modalities have been posited. These include Aristotle’s notion of a “common sense” (*sensus communis*) that unites and monitors the other senses (Gregoric 2011); the sense of one’s own actions and agency (Bayne 2011); the moral sense (originally proposed by Hutcheson 2002, although the perception of moral, ethical, and aesthetic properties via the other senses is also defended by Audi 2013); the perception of time and temporal properties (Phillips 2014); vomeronasal or pheromone perception (Meredith 2001 and Watson 1999, the latter cited under **Olfaction**); and various forms of “extrasensory” perception (Howes 2009). Whether any of these genuinely constitute forms of sensory awareness, as opposed to falling under a broader, more metaphorical use of the term “sense,” will depend on the precise criteria used to identify the senses (see **Individuating the Senses** for further discussion). For an overview of attempts to identify additional senses, as well as additional anthropological and cultural context, see Howes 2009 and Rivlin and Gravelle 1984. Audi, Robert. *Moral Perception*. Princeton, NJ: Princeton University Press, 2013. [ISBN: 9780691156484]

Defends a form of moral intuitionism, i.e., the perception of evaluative properties, such as goodness, badness, and beauty, as an element of sensory experience. Audi focuses on the connections among moral or aesthetic intuitions, moral knowledge, and the emotions. For the moral sense, see Hutcheson 2002.

Bayne, Tim. “The Sense of Agency.” In *The Senses: Classic and Contemporary Philosophical Perspectives*. Edited by Fiona Macpherson, 355–374. New York: Oxford University Press, 2011. [ISBN: 9780195385960]

Argues that the experience of agency through self-generated actions, or “agentive self-awareness,” is best thought of as a genuine sensory modality. Bayne argues that the alternative cognitive and telic (i.e., action-based) accounts each suffer from serious defects and, therefore, the perceptual model should at least be regarded as a viable option.

Gregoric, Pavel. *Aristotle on the Common Sense*. Oxford: Oxford University Press, 2011. [ISBN: 9780199277377]

A detailed examination of Aristotle’s account of the “common sense” (*sensus communis*), a higher-order perceptual capacity that unites and monitors the five senses—a notion not unlike the role of multisensory integration (see **Multisensory Perception**) in modern perceptual

psychology. Also provides a good overview of Aristotle's theory of perception and its relation to psychological theories throughout the Middle Ages and Early Modern periods.

Howes, David, ed. *The Sixth Sense Reader*. Oxford: Berg, 2009. [ISBN: 9781847882615]

Anthology that explores the search for a "sixth sense" and its dependence on, and interaction with, cultural factors. Includes articles on extrasensory perception (ESP) and mysticism, dreams, visions, and the feeling of being stared at, as well as more familiar cases of vestibular, temperature, muscle, and directional senses. (See also Rivlin and Gravelle 1984.)

Hutcheson, Francis. *An Essay on the Nature and Conduct of the Passions, with Illustrations on the Moral Sense[<http://oll.libertyfund.org/titles/885>]*. Edited by Aaron Garrett. Indianapolis, IN: Liberty Fund, 2002. [ISBN: 9780865973879] [class:dataSetItem-database]

A historical defense of the moral sense with which we "feel" the value of actions, originally published in 1742. Hutcheson was an influence on David Hume and Adam Smith and thought of the moral sense as a separate faculty, along with vision, touch, and so on, as well as distinct from both emotion and reasoning, the latter of which could both influence and be influenced by it. For moral and aesthetic perception more generally, see Audi 2013.

Meredith, Michael. "Human Vomeronasal Organ Function: A Critical Review of Best and Worst Cases." *Chemical Senses* 26 (2001): 433–445.

Reviews the evidence for pheromone perception in humans, i.e., the sensing of human-generated chemicals, whether consciously or otherwise, focusing on whether humans have a functional vomeronasal organ (VNO)—sometimes called "Jacobson's organ"—located within the nose (cf. Watson 1999, cited under *Olfaction*). Although the physiological and behavioral evidence for this remains highly controversial, VNOs are known to be present in many other animal species and, indeed, in human embryos.

Phillips, Ian. "Experience of and in Time." *Philosophy Compass* 9 (2014): 131–144. [doi:10.1111/phc3.12107]

Reviews some of the literature on the perception of temporal properties such as succession, duration, and change, and what, if any, implications this has for the temporal structure of experience. Phillips argues that the temporal properties that humans experience are "inherited" from the temporal structure of experience itself—e.g., one event being experienced before another—and that the arguments advanced to the contrary are unconvincing.

Rivlin, Robert, and Karen Gravelle. *Deciphering the Senses: The Expanding World of Human Perception*. New York: Simon and Schuster, 1984. [ISBN: 9780671461249]

An examination of the anthropology of the senses, in particular, cross-cultural approaches to counting the senses beyond the standard Aristotelian five (taste, sight, touch, smell, and hearing). Contains chapters on *Pain*, the development of the human sensory system, nonverbal sensory communication, and extrasensory perception. (See also Howes 2009.)

Nonhuman Senses

Among nonhuman species, animals possess many novel and unusual senses, as well as variations on, and extensions of, familiar human senses. Perhaps the sense most discussed in the philosophical literature is echolocation in bats, which is examined in detail from empirical and philosophical perspectives by Akins 1993. Many other fascinating cases, however, can be found in Hughes 1999, with a broader discussion of a range of issues in animal cognition, including sensory perception, in Andrews and Beck 2018. Keeley 2015 examines the relevance of nonhuman sensory modalities to philosophical questions concerning the nature and individuation of the senses (see *Individuating the Senses*), both in humans and nonhumans more generally.

For an in-depth account of the science of animal vision, see [Lazareva, et al. 2012](#). For smell in humans, animals, and plants, see [Watson 1999](#), cited under [*Olfaction*](#).

Akins, Kathleen. “What Is It Like to Be Boring and Myopic?” In *Dennett and His Critics*. Edited by Bo Dahlbom, 124–160. Cambridge, MA: Blackwell, 1993. [ISBN: 9780631185499]

Explores bats’ experience of echolocation, through the latest scientific and philosophical considerations. Akins argues that Thomas Nagel’s question of “What it is like to be a bat?” (*Philosophical Review* 83 [1974]: 435–450) is ambiguous between “What is the phenomenal character of bats’ echolocation experience?” and “What is the bat’s point of view?” Akin concludes that bats may lack the latter on the basis that they do not experience particulars, despite their experience having phenomenal character.

Andrews, Kristin, and Jacob Beck, eds. *The Routledge Handbook of Philosophy of Animal Minds*. London and New York: Routledge, 2018. [ISBN: 9781138822887]

A comprehensive collection on the philosophy and psychology of animal cognition, containing nearly fifty chapters on topics ranging from mental representation to animal consciousness and culture. Contributions that relate specifically to the senses include articles by Mohan Matthen (pp. 65–75) and Derek Brown (pp. 76–85) on animal color perception, Sean Allen-Hermanson on phenomenal character, Adam Shriver on the unpleasantness of pain in animals, and Maria Botero on touch and social cognition in chimpanzees.

Hughes, Howard C. *Sensory Exotica: A World beyond Human Experience*. Cambridge, MA: MIT Press, 1999. [ISBN: 9780262582049]

A comprehensive and accessible guide to nonhuman sensory modalities. Divided into four sections focusing on (1) the physiological and anatomical principles underlying biosonar, or echolocation; (2) biological compasses, e.g., magnetoreception; (3) electroperception; and (4) chemical communication, respectively. A good starting point for the nonspecialist.

Keeley, Brian L. “Nonhuman Animal Senses.” In *The Oxford Handbook of Philosophy of Perception*. Edited by Mohan Matthen, 853–870. Oxford: Oxford University Press, 2015. [ISBN: 9780199600472]

Considers the relationship between the senses of human and animals, arguing that the two are, in important ways, continuous with one another. Drawing on scientific evidence concerning infrared reception and magnetoreception, Keeley concludes that much work remains to address conceptual and metatheoretical questions in the philosophy of nonhuman perception.

Lazareva, Olga F., Toru Shimizu, and Edward A. Wasserman, eds. *How Animals See the World: Comparative Behavior, Biology, and Evolution of Vision*. New York: Oxford University Press, 2012. [ISBN: 9780195334654]

Multidisciplinary collection on the science and diversity of vision across the animal kingdom. Sections cover (1) perceptual grouping and segmentation; (2) luminance, contrast, and spatial and temporal resolution; (3) object perception and recognition; (4) motion perception; (5) visual attention; and (6) different dimensions of visual perception. A detailed and valuable reference work.

CROSSMODAL PHENOMENA

Since the late 20th century, psychologists and philosophers increasingly have become interested in how individual sensory modalities combine and interact to create a “multisensory” experience of the world. [*Multisensory Perception*](#) includes some of the key works that deal with that topic, including multisensory integration and the nature of crossmodal (or multimodal) experiences. [*Synesthesia*](#) discusses specific philosophical issues relating to this condition in

which subjects experience objects via one submodality, e.g., shape, as possessing properties that are normally associated with a different submodality, e.g., color. [*Molyneux's Question*](#) concerns the mechanisms for shape representation and identification across sensory modalities. [*Other Crossmodal Phenomena*](#) covers crossmodal attention, spatial representation, crossmodal correspondences, and crossmodal imagery. For general scientific background, see [Calvert, et al. 2004](#) and [Stein 2012](#). For comparisons between sensory modalities, see [*Contrasting the Senses*](#).

Multisensory Perception

The topic of multisensory perception— i.e., perception involving two or more distinct sensory modalities—may be further subdivided into the study of multisensory experience ([Macpherson ed. 2011](#)) and the multisensory processing that underpins it ([Briscoe 2016](#)). Furthermore, although the two terms are sometimes used interchangeably, many philosophers and psychologists draw a distinction between multisensory integration, either at the level of experience or multisensory processing, and crossmodal effects in which processing of information from one modality causally affects processing or experience in another modality (see [Connolly 2014](#)). Although it is now widely accepted that perceptual experience is multisensory (see [Bayne and Spence 2015](#), [O'Callaghan 2017](#), and [Matthen 2017](#)) and involves some form of multisensory integration or binding, [Spence and Bayne 2015](#) strikes a note of caution concerning the empirical evidence for this claim. For a cross-section of recent scientific research on multisensory perception, see [Calvert, et al. 2004](#) and [Stein 2012](#), both of which are somewhat technical and may be difficult for the nonspecialist. [Chen and Vroomen 2013](#) provides an accessible overview of the role of space and time in intersensory binding. For discussion of the philosophical issues raised by various forms of multisensory perception, see [Bennett and Hill 2014](#) and [Stokes, et al. 2015](#).

Bayne, Tim, and Charles Spence. "Multisensory Perception." In *The Oxford Handbook of Philosophy of Perception*. Edited by Mohan Matthen, 603–620. Oxford: Oxford University Press, 2015. [ISBN: 9780199600472]

[Provides an overview of various forms of multisensory perception and their philosophical implications for debates concerning modularity, perceptual content, and the structure of consciousness. Contains an extensive bibliography. \(For a contrasting view, see \[Spence and Bayne 2015\]\(#\).\)](#)

Bennett, David, and Christopher Hill, eds. *Sensory Integration and the Unity of Consciousness*. Cambridge MA: MIT Press, 2014. [ISBN: 9780262027786]

[A wide-ranging collection of papers on a variety of topics relating to multisensory perception. Chapters dealing specifically with multisensory integration are "The Multisensory Nature of Perceptual Consciousness" by Tim Bayne \(pp. 15–36\), "Intermodal Binding Awareness" by Casey O'Callaghan \(pp. 73–104\), "Multimodal Unity and Multimodal Binding" by Frédérique de Vignemont \(pp. 125–150\), and "Modeling Multisensory Integration" by Loes C. J. van Dam, et al. \(pp. 209–229\).](#)

Briscoe, Robert Eamon. "Multisensory Processing and Perceptual Consciousness: Part I." *Philosophy Compass* 11 (2016): 121–133.

[An excellent introduction to the mechanisms of multisensory processing, integration, perceptual adaptation, and crossmodal spatial attention. Differentiates between the causal influences "optimizing" and "generative" multisensory integration in which only the latter](#)

gives rise to the representation of new kinds of properties, e.g., in flavor perception (see [*Sensory Modalities: Taste and Flavor*](#)).

Calvert, Gemma A., Charles Spence, and Barry E. Stein, eds. *The Handbook of Multisensory Processes*. Cambridge, MA: MIT Press, 2004. [ISBN: 9780262033213]

An influential collection of psychological and neuroscientific studies on multisensory perception. Some of these studies have since been supplanted by recent research, but this remains a valuable and important reference volume, although highly technical in places. (See also [Stein 2012](#).)

Chen, Lihan, and Jean Vroomen, “Intersensory Binding across Space and Time: A Tutorial Review.” *Attention, Perception, & Psychophysics* 75 (2013): 790–811. [doi:10.3758/s13414-013-0475-4]

Presents an overview of the scientific literature on the way in which space and time affect the binding of stimuli across multiple sensory modalities, creating spatial and temporal “ventriloquism” effects that last beyond the immediately presented stimuli. Also examines the role of attention in multisensory binding and the criteria for intersensory pairing.

Connolly, Kevin. “Making Sense of Multiple Senses.” In *Consciousness Inside and Out: Phenomenology, Neuroscience, and the Nature of Experience*. Edited by Richard Brown, 351–364. Dordrecht, The Netherlands: Springer Netherlands, 2014. [ISBN: 9789400760004]

Argues that the existence of crossmodal effects, such as the McGurk effect, or motion-bounce illusion does not require the content of the relevant experiences to be fundamentally multimodal. Instead, Connolly argues that crossmodal experiences may involve unimodal content plus an additional amodal component that is nonmodality specific.

Macpherson, Fiona. “Cross-Modal Experiences.” *Proceedings of the Aristotelian Society* 111 (2011): 429–468.

Uses the various criteria for individuating the senses described in [Macpherson ed. 2011](#) and [Macpherson 2015](#) (cited under [*Individuating the Senses*](#)) to construct an exhaustive taxonomy of unimodal and crossmodal experiences, according to which a given experience may be unimodal or crossmodal in some, but not all, respects.

Matthen, Mohan. “Is Perceptual Experience Normally Multimodal?” In *Current Controversies in Philosophy of Perception*. Edited by Bence Nanay, 121–135. New York and London: Routledge, 2017. [ISBN: 9781138840072]

Defends the view that perceptual experience is “richly multimodal” in O’Callaghan’s sense that “(a) it is not co-consciousness of separate unisensory states, and (b) its content is not the mere conjunction of the content of unisensory states” (p. 123). Matthen rejects the “atomist” view that the senses assign logically independent properties to the objects of experience in favor of a multimodal (as opposed to amodal) view of our experience of space and time.

O’Callaghan, Casey. “Enhancement through Coordination.” In *Current Controversies in Philosophy of Perception*. Edited by Bence Nanay, 109–120. New York and London: Routledge, 2017. [ISBN: 9781138840072]

Defines a number of different ways in which experience might be multisensory, arguing that mature human experience is “richly multisensory” on the basis that it draws on multiple senses to improve accuracy (cf. [Matthen 2017](#)). Consequently, according to O’Callaghan, sensory experiences are not subdivisible into multiple unimodal parts, nor does characterizing an experience as being in one particular modality preclude that it is also in another.

Spence, Charles, and Tim Bayne. “Is Consciousness Multisensory?” In *Perception and Its Modalities*. Edited by Dustin Stokes, Mohan Matthen, and Stephen Biggs, 95–132. Oxford: Oxford University Press, 2015. [ISBN: 9780199832811]

Examines the debate between multisensory and unisensory views of the architecture of consciousness, and how this issue might be settled. Somewhat controversially, Spence and Bayne conclude that evidence for the multisensory view is “surprisingly elusive” (p. 122) as most of the current data can also be explained by rapid switching between modalities, as opposed to experiences associated with distinct modalities at the same time (see also [Spence and Bayne 2015](#)).

Stein, Barry E., ed. *The New Handbook of Multisensory Processes*. Cambridge, MA: MIT Press, 2012. [ISBN: 9780262017121]

An extensive collection of papers on the psychology and neuroscience of multisensory processing. Includes sections on multisensory integration, perceptual learning, attention, communication, and speech, with helpful section-level introductions written by subject experts. (See also [Calvert, et al. 2004](#).)

Stokes, Dustin, Mohan Matthen, and Stephen Biggs, eds. *Perception and Its Modalities*. Oxford: Oxford University Press, 2015. [ISBN: 9780199832811]

A collection of recent philosophical work, including a section on multimodal perception. Chapters include “Is Consciousness Multisensory?” by Charles Spence and Tim Bayne (pp. 95–132); “Not All Perceptual Experience Is Modality Specific” by Casey O’Callaghan (pp. 133–165); and “Is Audio-Visual Perception ‘Amodal’ or ‘Crossmodal’?” by Matthew Nudds (pp. 166–188), also cited under *Other Crossmodal Phenomena*.

Synesthesia

The precise definition of synesthesia, along with its status as a unified condition as opposed to a family of related phenomena, is controversial (see [Macpherson 2007](#) and [Deroy 2017](#)). However, it may be loosely characterized as a condition in which experiences in one sensory modality (e.g., audition) are always accompanied by what would be for most people seemingly unrelated experiences in another modality (e.g., vision). Additionally, there are forms of synesthesia in which experiences in one modality may be accompanied by elements of experiences in that same modality. For example, in grapheme-color synesthesia, letters and numbers are visually experienced as possessing characteristic colors unrelated to the color of ink used to print them. The extent to which synesthesia may be due to memory-based effects is, however, controversial (see [Brogaard, et al. 2014](#); [Ward and Mattingley 2006](#)). Other topics of philosophical interest include whether synesthesia provides a counterexample to various forms of functionalism ([Macpherson 2007](#)), whether synesthetic experiences are reducible to a combination of ordinary senses experiences or are sui generis ([Auvray and Deroy 2015](#)) or represent high-level properties ([Matey 2014](#)), and the condition’s implications for modularity and feature-binding ([Brogaard, et al. 2014](#)). For accessible introductions to the neuroscientific and genetic basis of synesthesia, see [Cytowic and Eagleman 2009](#), [Baron-Cohen and Harrison 1997](#), and [Simner and Hubbard 2013](#). The implications of synesthesia for art and literature are discussed in [Campen 2007](#).

Auvray, Malika, and Ophelia Deroy. “How Do Synaesthetes Experience the World?” In *The Oxford Handbook of Philosophy of Perception*. Edited by Mohan Matthen, 640–658. Oxford: Oxford University Press, 2015. [ISBN: 9780199600472]

Examines different forms of synesthesia,, which the authors define as involving a distinctive kind of conscious state that is not reducible to combinations of ordinary non-synesthetic

experiences (the so-called dual model). Also considers, based on their representational and functional profiles, whether these states should be considered exclusively perceptual. (See also [Macpherson 2007](#).)

Baron-Cohen, Simon, and John E. Harrison, eds. *Synaesthesia: Classic and Contemporary Readings*. Cambridge, MA: Blackwell, 1997. [ISBN: 9780631197638]

A wide-ranging collection of papers from modern cognitive neuroscience, developmental neurobiology, and clinical reports of various forms of synesthesia.

Brogaard, Berit, Kristian Marlow, and Kevin Rice. “The Long-Term Potentiation Model for Grapheme-Color Binding in Synaesthesia.” In *Sensory Integration and the Unity of Consciousness*. Edited by David Bennett and Christopher Hill, 37–72. Cambridge MA: MIT Press, 2014. [ISBN: 9780262027786]

Reviews the recent empirical literature on grapheme-color synesthesia and proposes a mechanism for at least some forms of this condition that is grounded in memory. Also examines the wider philosophical implications of synesthesia for modularity and feature binding.

Campen, Crétien van. *The Hidden Sense: Synesthesia in Art and Science*. Cambridge, MA: MIT Press, 2007.

Examines the implications of synesthesia from the dual perspectives of science and the arts. Campen considers what the function of synesthesia might be and what, if anything, this can explain about ordinary, non-synesthetic sensory experience.

Cytowic, Richard E., and David M. Eagleman. *Wednesday Is Indigo Blue: Discovering the Brain of Synesthesia*. Cambridge, MA: MIT Press, 2009. [ISBN: 9780262012799]

Accessible book on the neuroscientific and genetic basis of synesthesia. Cytowic’s other works—*Synesthesia: A Union of the Senses*, 2d ed. (Cambridge, MA: MIT Press, 2002), and *The Man Who Tasted Shapes*, Rev. ed. (Cambridge, MA: MIT Press, 2003)—were partly responsible for popularizing synesthesia as a legitimate topic for scientific and philosophical inquiry.

Deroy, Ophelia, ed. *Sensory Blending: On Synaesthesia and Related Phenomena*. Oxford: Oxford University Press, 2017. [ISBN: 9780199688289]

A collection of new philosophical and scientific essays examining the broader theoretical lessons that arise from synesthesia and related conditions. Covers the definition of synesthesia, the reportability of experiences, the way in which synesthetic experiences relate to other kinds of “sensory blending,” and the implications of such cases for an understanding of perception in general.

Macpherson, Fiona. “Synaesthesia, Functionalism and Phenomenology.” In *Cartographies of the Mind: Philosophy and Psychology in Intersection*. Vol. 4. Edited by Mario De Caro, Francesco Ferretti, and Massimo Marraffa, 65–80. Studies in Brain and Mind. Dordrecht, The Netherlands: Springer, 2007. [ISBN: 9781402054440]

Offers a disjunctive definition of synesthesia and argues that it does not, as some philosophers and psychologists have claimed, provide a counterexample to forms of functionalism that include a normative element. (See also [Auvray and Deroy 2015](#).)

Matey, Jennifer. “Can Blue Mean Four?” In *Sensory Integration and the Unity of Consciousness*. Edited by David Bennett and Christopher Hill, 151–170. Cambridge MA: MIT Press, 2014. [ISBN: 9780262027786]

Argues for the representation of high-level properties in visual experience on the basis of grapheme-color synesthesia in which subjects experience numerical figures as having colors.

For general background on visual representation, see [Siegel 2006](#), cited under [*Sensory Modalities: Vision*](#).

Simner, Julia, and Edward Hubbard, eds. *The Oxford Handbook of Synesthesia*. Oxford: Oxford University Press, 2013. [ISBN: 9780191750885]

Comprehensive reference work containing contributions from many of the leading researchers on synesthesia. Contains sections on the origins and different types of synesthesia and its interaction with attention and perception, neurological basis, and crossmodality in the general population.

Ward, Jamie, and Jason Mattingley. "Synaesthesia: An Overview of Contemporary Findings and Controversies." *Cortex* 42.2 (2006): 129–136.

A special issue of recent scientific research on synesthesia. Focusing mainly on grapheme-color synesthesia, topics include the authenticity of the condition, its possible basis in memory, interactions between real and synesthetic colors, top-down versus bottom-up effects, and susceptibility of synesthetes to visual priming and pop-out effects. The introduction provides a good overview of work in the field in the early 2000s.

Molyneux's Question

In his 1688 letter to John Locke, William Molyneux [1978](#) posed the question of whether a congenitally blind person whose sight was restored would be able to identify, by sight alone, which of two objects was a cube or a sphere. This question has since stimulated much debate concerning the nature of spatial representation in different modalities (for an overview, see [Degenaar and Lokhorst 2014](#)), including attempts to answer the question empirically, of which [Sinha, et al. 2014](#) is one of the most recent and influential (see [Van Cleve 2014](#) for a critical discussion). [Evans 1985](#) (cf. [Campbell 1996](#)) argues that visual and tactile experiences share a common spatial frame of reference, motivating a positive response to Molyneux's question, although [Eilan 1993](#) takes this to be a contingent matter. For temporal and methodological variants of Molyneux's question, see [Richardson 2015](#) and [Chirimuuta and Paterson 2015](#), both cited under [*Contrasting the Senses*](#).

Campbell, John. "Molyneux's Question." *Philosophical Issues* 7 (1996): 301–318.

Analyzes Molyneux's question in terms of a contrast between "internalist" versus "radical externalist" views of shape perception. According to Campbell, the former takes the phenomenal character of shape perception to be determined by the internal geometry of sensations; the latter, by amodal characteristics of external objects that in turn explain the crossmodal equivalences between sight and touch.

Degenaar, Marjolein, and Gert-Jan Lokhorst. "*Molyneux's Problem[<http://plato.stanford.edu/archives/spr2014/entries/molyneux-problem/>]*." In *The Stanford Encyclopedia of Philosophy*. Edited by Edward N. Zalta, 2014.

A good introduction to, and overview of, Molyneux's question, along with historical and contemporary attempts to answer the question both experimentally and theoretically.

Eilan, Naomi M. "Molyneux's Question and the Idea of an External World." In *Spatial Representation: Problems in Philosophy and Psychology*. Edited by Naomi Eilan, Rosaleen McCarthy, and Bill Brewer, 236–255. Cambridge, MA: Blackwell, 1993. [ISBN: 9780631183556]

Examines precisely what kinds of modality-specificity might motivate a negative answer to Molyneux's question, and how the representation or "mapping" of space enables subjects both to reidentify and grasp the interrelation of external locations. Eilan argues that the answer to

Molyneux's question is an empirical matter that turns on developmental and evolutionary contingencies relating to the emergence of human spatial mapping abilities.

Evans, Gareth. "Molyneux's Question." In *Collected Papers*. Edited by Gareth Evans, 364–399. Oxford: Clarendon, 1985. [ISBN: 9780198236276]

A classic paper in which Evans argues that visual and tactile experiences share a common spatial frame of reference due to their representing egocentric locations in a shared behavioral space (cf. [Clark 2011](#), cited under [*Other Crossmodal Effects*](#)). For critical commentary, see John Campbell's review of this posthumously published collection ("Collected Papers by Gareth Evans: Review by John Campbell," *The Journal of Philosophy* 86 [1989]: 156–163). For discussion of Evans's temporal variant of Molyneux's question, see [Richardson 2014](#).

Molyneux, William. "William Molyneux to the Author of the *Essai Philosophique concernant L'Entendement*." In *The Correspondence of John Locke*. Edited by E. S. De Beer, Vol. 3, no. 1064, 482–483. Oxford: Clarendon, 1978.

Molyneux's original letter to Locke, written in 1688 following the publication of an extract of Locke's *An Essay Concerning Human Understanding* in French. Though Locke never provided a response to Molyneux's question, the two struck up a correspondence, and Locke included the question in the 1694 edition of his *Essay* ([Degenaar and Lokhorst 2014](#)).

Richardson, Louise. "Space, Time and Molyneux's Question." *Ratio* 27 (2014): 483–505.

Examines the reasons behind an apparent asymmetry between the spatial and temporal variants of Molyneux's question described by [Evans 1985](#). On the basis of phenomenological features of a variety of modalities, Richardson argues that perception has spatial, but not temporal, perspectival character, i.e., there is no distinction "between the temporal location from which one perceives things, and the apparent temporal location of those perceived things" (p. 502).

Sinha, Pawan, Jonas Wulff, and Richard Held. "Establishing Cross-Modal Mappings: Empirical and Computational Investigations." In *Sensory Integration and the Unity of Consciousness*. Edited by David Bennett and Christopher Hill, 171–192. Cambridge, MA: MIT Press, 2014. [ISBN: 9780262027786]

Groundbreaking work based on the removal of congenital cataracts, paving the way for an empirical answer to Molyneux's question, although the details remain controversial. Provisionally concludes that crossmodal mappings are not available at the outset of vision, but they require linkages to be established, typically occurring relatively rapidly as a result of early visual experiences. (See also [Van Cleve 2014](#).)

Van Cleve, James. "Berkeley, Reid, and Sinha on Molyneux's Question." In *Sensory Integration and the Unity of Consciousness*. Edited by David Bennett and Christopher Hill, 193–208. Cambridge MA: MIT Press, 2014. [ISBN: 9780262027786]

Compares Berkeley's negative answer and Reid's positive answer to Molyneux's question with the empirically based negative answer given by [Sinha, et al. 2014](#), raising some issues concerning the significance of the latter.

Other Crossmodal Phenomena

Other topics of philosophical interest involving multiple sensory modalities include the nature of spatial representation across the senses ([Eilan, et al. 1993](#)). See also [*Molyneux's Question*](#), [Matthen 2017](#) (cited under [*Multisensory Perception*](#)), crossmodal cuing and attention ([Clark 2011](#)), active perception and sensory exploration ([Gibson 1988](#)), correspondences between stimuli presented to different sensory modalities ([Spence 2011](#) and [Parise, et al. 2016](#)), and crossmodal imagery ([Spence and Deroy 2013](#)). For multisensory integration and processing, see

[*Multisensory Perception*](#). For comparisons between different sensory modalities, see [*Contrasting the Senses*](#).

Clark, Austen. “Cross-Modal Cuing and Selective Attention.” In *The Senses: Classic and Contemporary Philosophical Perspectives*. Edited by Fiona Macpherson, 375–396. New York: Oxford University Press, 2011. [ISBN: 9780195385960]

Examines the implications of a series of experiments by Charles Spence and John Driver, in which a cue presented at a location enhances subsequent discriminations at that location, for the representation of spatial location. Clark argues that the results of these experiments favor the representation of space in a way that is non-modality specific by “variables that range over locations . . . independently of what objects are found at those locations” (p. 394).

Eilan, Naomi, Rosaleen McCarthy, and Bill Brewer. *Spatial Representation*. Oxford: Blackwell, 1993. [ISBN: 9780631183556]

A stimulating interdisciplinary collection of essays on the representation of space both within and across sensory modalities, for action, and in the ventral (“what”) and dorsal (“where”) streams of the visual system, first proposed by Ungerleider and Mishkin, and popularized by Milner and Goodale in their work on blindsight (for further information, see Twedt and Proffitt 2015, cited under [*Anthologies: Psychology and Neuroscience*](#)).

Gibson, Eleanor J. “Exploratory Behavior in the Development of Perceiving, Acting, and the Acquiring of Knowledge.” *Annual Review of Psychology* 39 (1988): 1–42.

Provides a psychological account of perceptual exploration, in particular, the relation between sensory perception, action, and knowledge-acquisition in early childhood. Gibson focuses on the perception of affordances, first proposed by [Gibson 1966](#) (cited under [*Anthologies and Reference: Psychology and Neuroscience*](#)), and the way in which the senses interact to create an embodied perspective on the world. For further discussion of exploratory touch, see [Lederman and Klatzky 2009](#), cited under [*Sensory Modalities: Touch*](#).

Parise, Cesare V., Charles Spence, and Ophelia Deroy, eds. *Special Issue on Crossmodal Correspondences. Multisensory Research* 29 (2016).

Special issue containing recent scientific research on crossmodal correspondences across a wide variety of modalities. For a detailed review of the empirical literature, see [Spence 2011](#).

Spence, Charles. “Crossmodal Correspondences: A Tutorial Review.” *Attention, Perception and Psychophysics* 73 (2011): 971–995.

A comprehensive review of the empirical literature on crossmodal matching and correspondences, ranging from Wolfgang Köhler’s early work on the “Bouba–Kiki” effect to Spence’s research on multisensory integration and perception. Also contains an extensive bibliography. For recent developments, see [Spence and Deroy 2013](#).

Spence, Charles, and Ophelia Deroy. “Crossmodal Mental Imagery.” In *Multisensory Imagery*. Edited by Simon Lacey and Rebecca Lawson, 157–183. New York: Springer, 2013. [ISBN: 9781461458784]

Examines a variety of philosophical issues concerning crossmodal mental imagery in which the presentation of stimuli in one sensory modality results in the formation of imagery in a different modality. The authors mark a distinction between “crossmodal” and “multimodal” imagery, in which the latter involves a single object represented as possessing properties from multiple modalities (cf. [Spence and Bayne 2015](#), cited under [*Multisensory Perception*](#)).

CONTRASTING THE SENSES

The articles cited in this section focus on comparisons and differences between sensory modalities that a comprehensive theory of sensory perception would need to accommodate.

Martin 1992 casts doubt on whether such a unified theory is possible, whereas Chirimuuta and Paterson 2015 argues that all of the senses may be encompassed by a unified conceptual framework. Structural asymmetries between modalities might concern the way in which they present space (Martin 1992), the role of external objects (Smith 2011), and their agential features (Richardson 2015). Myin, et al. 2015 considers the relation between the structural features of a range of actual and possible sensory modalities and their phenomenal or subjective character. The temporal character of a variety of sensory modalities is also discussed by Richardson 2014, cited under [*Crossmodal Phenomena: Molyneux's Question*](#).

Chirimuuta, Mazviita, and Mark Paterson. "A Methodological Molyneux Question: Sensory Substitution, Plasticity, and the Unification of Perceptual Theory." In *Perception and Its Modalities*. Edited by Dustin Stokes, Mohan Matthen, and Stephen Biggs, 410–431. Oxford: Oxford University Press, 2015. [ISBN: 9780199832811]

Poses a methodological Molyneux question concerning whether a single conceptual framework can be extended to include all of the senses. On the basis of empirical evidence from sensory substitution, neuroplasticity, and Braille reading, the authors argue that, contrary to the skepticism of Martin 1992, a positive answer to this question may be possible.

Martin, Michael. "Sight and Touch." In *The Contents of Experience*. Edited by Tim Crane, 196–215. New York: Cambridge University Press, 1992. [ISBN: 9780521417273]

Contrasts the experience of space—empty space, in particular—between visual and tactile modalities (see also Richardson 2010, cited under [*Sensory Modalities: Vision*](#), and Young 2017, cited under [*Sensory Modalities: Audition*](#)). Martin argues that asymmetries between the phenomenology of vision and touch place pressure on the idea that a single theory of perception can account for the rich variety of ways in which humans experience the world (for a reply, see Chirimuuta and Paterson 2015).

Myin, Erik, and Ed Cooke, and Karim Zahidi. "Morphing Senses." In *Perception and Its Modalities*. Edited by Dustin Stokes, Mohan Matthen, and Stephen Biggs, 393–409. Oxford: Oxford University Press, 2015. [ISBN: 9780199832811]

Drawing on the hypothetical example of "smelling color," along with various cases of sensory substitution, the authors evaluate which combinations of answers to the following questions are defensible: (1) whether adding features of a source sensory modality to a different target modality would alter the phenomenal character of that target modality, and (2) whether the phenomenal character of a given modality is dependent solely on structural features of that modality.

Richardson, Louise. "Perceptual Activity and Bodily Awareness." *Proceedings of the Aristotelian Society* 115.2 (2015): 147–165.

Argues that ordinary sense-perception and various forms of bodily awareness differ in their agential features due to the nature of "perceptual monitoring" across different modalities. Concludes that bodily awareness is not a form of sense-perception, although this is a contingent matter.

Smith, A. D. "Tastes, Temperatures, and Pains." In *The Senses: Classic and Contemporary Philosophical Perspectives*. Edited by Fiona Macpherson, 341–354. New York: Oxford University Press, 2011. [ISBN: 9780195385960]

Summarizes elements of Smith's *The Problem of Perception* (Cambridge, MA: Harvard University Press, 2002) in which he argues that sensory modalities can function either perceptually or non-perceptually, i.e., as a mere sensation that lacks any external object. According to Smith, experiences of temperature, taste, etc., are only "derivatively perceptual" due to their dependence on touch, whereas pains are "non-perceptual," which explains why they are not attributed to external objects.

SENSORY ENHANCEMENT AND DEFICITS

Sensory substitution occurs when stimuli in one sensory modality (e.g., touch) are used to compensate for the loss or impairment of another modality (e.g., vision), as well as various forms of sensory loss, including issues surrounding loss of vision, hearing, and proprioception. Other ways in which the senses may be enhanced include perceptual learning and cognitive penetration (see the *Oxford Bibliographies* article "[*Modularity\[obo-9780195396577-0150\]](#)"*). Other partial ways in which sensory perception and awareness can break down include color-blindness, blindsight, deaf-hearing, and so on. In this section, the focus is on cases of whole sensory loss.

Sensory Substitution

As well as having obvious therapeutic applications, the use of sensory substitution devices (SSDs), such as those pioneered by [Bach-y-Rita 1972](#), gives rise to a number of philosophical questions concerning the nature, and sensory modality, of the resulting experience. [Kiverstein, et al. 2015](#) provides an excellent overview, with recent scientific studies presented in [Auvray and Harris 2014](#). [Deroy and Auvray 2015](#) examines whether these experiences are best described as hybrids of existing sensory modalities or as new, novel modalities in their own right. For the implications of sensory substitution for the individuation of the senses, see [*Individuating the Senses*](#), as well as [Chirimuuta and Paterson 2015](#), and [Myin, et al. 2015](#), both cited under [*Contrasting the Senses*](#).

Auvray, Malika, and Laurence R. Harris, eds. *Special Issue on Sensory Substitution. Multisensory Research* 27 (2014).

A collection of recent scientific studies on sensory substitution, including papers on tactile-vestibular substitution, object representation, and the chemical senses.

Bach-y-Rita, Paul. *Brain Mechanisms in Sensory Substitution*. New York: Academic Press, 1972.

Reports on the author's groundbreaking work in the development of sensory substitution devices—in particular, Tactile–Visual Substitution Systems (TVSS)—and the effects that these have on the brain. Many long-term users report experiencing the presentation of distal (as opposed to proximal) objects, with a vision-like (as opposed to tactual) phenomenal character.

Deroy, Ophelia, and Malika Auvray. "A Crossmodal Perspective on Sensory Substitution." In *Perception and Its Modalities*. Edited by Dustin Stokes, Mohan Matthen, and Stephen Biggs, 327–349. Oxford: Oxford University Press, 2015. [ISBN: 9780199832811]

Examines how the various individuation criteria proposed by Grice in [Macpherson ed. 2011](#) (pp. 83–100, cited under [*Individuating the Senses*](#)), apply to sensory substitution devices, arguing that these generate hybrid experiences that do not fit neatly into standard sensory modalities.

Kiverstein, Julian, Mirko Farina, and Andy Clark. "Substituting the Senses." In *The Oxford Handbook of Philosophy of Perception*. Edited by Mohan Matthen, 659–675. Oxford: Oxford University Press, 2015. [ISBN: 9780199600472]

An excellent overview of the philosophical issues that arise in connection with sensory substitution devices, including the individuation of the senses (see [*Individuating the Senses*](#)), the phenomenal character of the resulting experience, and the attribution of the cause of stimulation to distal rather than proximal objects. Includes an extensive bibliography.

Sensory Loss

Although there is not a great amount of philosophical work on sensory loss, some prominent cases are documented in detail by [Magee and Milligan 1998](#) (blindness), [Herrmann 1999](#) (deaf-blindness), [Tafalla 2013](#) (anosmia), [Cole 2016](#) and [McNeill, et al. 2009](#) (proprioception), among others. [Wallace 2012](#) argues that deficits in multisensory processing may provide a framework for understanding a diverse range of conditions including autistic spectrum disorder, dyslexia, and schizophrenia. [Ramachandran and Hirstein 1998](#) discusses cases in which sensations are felt as being located in missing “phantom” limbs or body parts. [Lantos 2012](#) provides a clinical perspective on the ethical issues involved in fitting young children with cochlear implants. Finally, [Zubek 1969](#) presents a collection of research on sensory deprivation. For pain deficits, including pain asymbolia, see [Bain 2015](#), cited under [*Sensory Modalities: Pain*](#).

Cole, Jonathan. *Losing Touch: A Man without His Body*. Oxford: Oxford University Press, 2016. [ISBN: 9780198778875]

Documents the experiences of Ian Waterman, who lost proprioceptive bodily awareness as a result of illness, making him unable to feel the position or movement of his body. Waterman was subsequently able to relearn how to carry out a range of activities using visual feedback. For further philosophical commentary, see [McNeill, et al. 2009](#).

Herrmann, Dorothy. *Helen Keller: A Life*. Chicago: University of Chicago Press, 1999. [ISBN: 9780226327631]

Biography of Helen Keller, the deaf-blind American author and political activist. After losing her sight and hearing at an early age due to illness, Keller learned to communicate via sign language and Braille and became a prominent campaigner for the rights of deaf people, and women. Her autobiography, *The Story of My Life*, is published by Bantam Classic (New York: 2005).

Lantos, John D. “Ethics for the Pediatrician: The Evolving Ethics of Cochlear Implants in Children.” *Pediatrics in Review* 33 (2012): 323–326. [doi:10.1542/pir.33-7-323]

Summarizes the recent debate surrounding the provision of cochlear implants to deaf, including prelingual, children. This issue has generated some controversy, in part due to early opposition by some (although by no means all) members of the deaf community, as well as an inequality of access and outcomes for individuals who come from less affluent backgrounds.

Magee, Bryan, and Martin Milligan. *Sight Unseen*. London: Phoenix House, 1998. [ISBN: 9780753805039]

A highly personal and philosophically informed discussion of the range of blind experience, ranging from those who are born blind to those who, like Milligan, lose their sight, or who subsequently regain their sense of vision (see also [*Crossmodal Phenomena: Molyneux’s Question*](#)). Argues against the view that blindness is a simple experience.

McNeill, David, Liesbet Quaegebeur, and Susan Duncan. “The Man Who Lost His Body.” In *Handbook of Phenomenology and Cognitive Science*. Edited by Shaun Gallagher and Daniel Schmicking, 519–543. Dordrecht, The Netherlands: Springer Netherlands, 2009.

Examines the link between gesture and meaning in the case of Ian Waterman, who experienced total deafferentation of his body from the neck down (see [Cole 2016](#)). While the discussion

focuses largely upon the coordination of action, use of hand gestures, and Merleau-Ponty's account of signification, the details are instructive and provide a phenomenological treatment of the loss of proprioception.

Ramachandran, Vilayanur S., and William Hirstein. "The Perception of Phantom Limbs: The D. O. Hebb Lecture." *Brain* 121 (1998): 1603–1630.

Review of scientific research on "phantom limb" syndrome, a condition in which subjects feel sensations as being located in an amputated or otherwise missing body part. Argues that the cause of mislocalization is due to interactions between the remapping of sensations and a "genetically specified body image." Also discusses modality-specific effects (touch, temperature, and pain), and interactions between real and phantom movements.

Tafalla, Marta. "A World without the Olfactory Dimension." *Anatomical Record* 296 (2013): 1287–1296.

The author, a philosopher and congenital anosmic, describes from a first-hand perspective how she first discovered that she lacked a sense of smell, along with the effects that this has on her attitudes toward food, her body, other people, the physical environment, and time.

Wallace, Mark T. "The Impact of Multisensory Alterations in Human Developmental Disabilities: The Tip of an Iceberg?" In *The New Handbook of Multisensory Processing*. Edited by Barry E. Stein, 645–655. Cambridge, MA: MIT Press, 2012. [ISBN: 9780262017121]

Wallace provides an overview of the links between deficits in multisensory, especially temporal, integration and developmental, disabilities including autistic spectrum disorder, dyslexia, and schizophrenia. Cites a growing body of evidence that multisensory temporal processes may offer a unifying framework for understanding such disabilities. This volume also contains chapters on the links between sensory integration and particular developmental conditions.

Zubek, John P., ed. *Sensory Deprivation: Fifteen Years of Research*. New York: Appleton-Century-Crofts, 1969.

A critical review of scientific research on the effects of sensory deprivation, prolonged exposure to which causes many subjects to experience sensory hallucinations and other illusory effects. Includes references to hallucinogenic drugs, including LSD and psilocybin.